Linking Climate Change & Hydro-meteorological hazards in south West Indian ocean & Extreme Events

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UoM, 29 October 2012

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- **Extreme events in SWIO**
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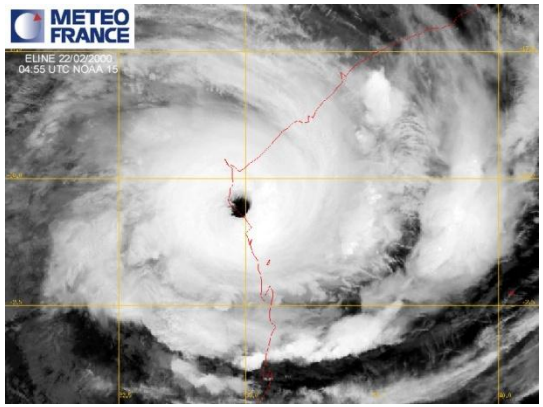
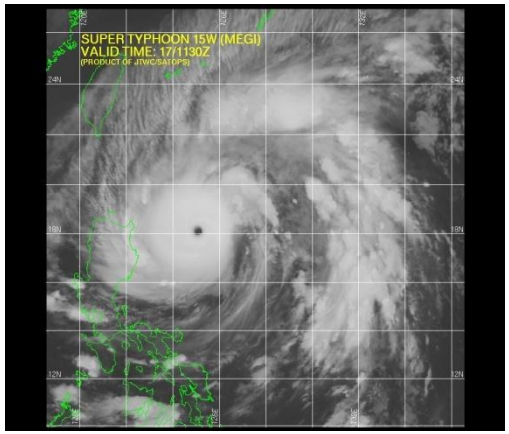
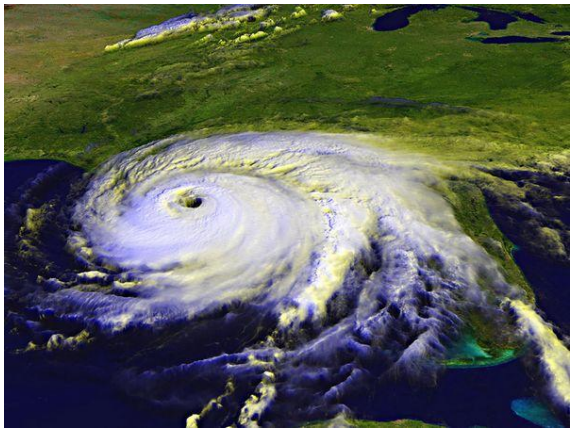
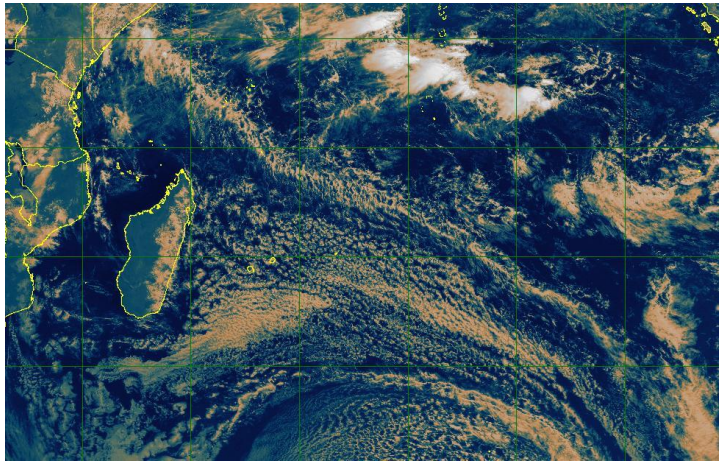
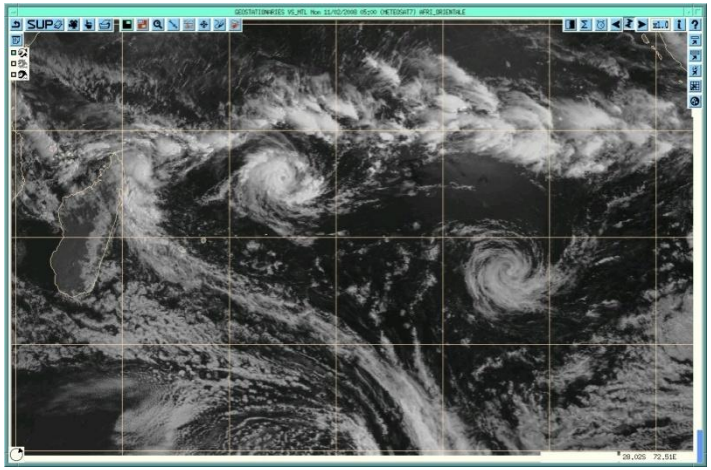
Cyclones


METEO FRANCE
ELINE 22/02/2000
04:55 UTC NOAA 15

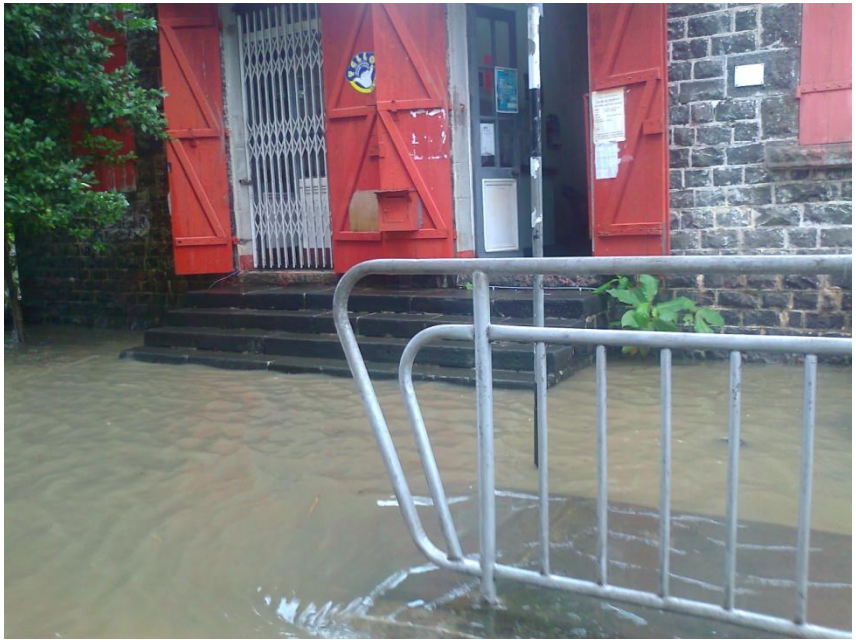

SUPER TYPHOON 15W (MEGI)
VALID TIME: 17/1130Z
(PRODUCT OF JTWC/SATOPS)







Flood

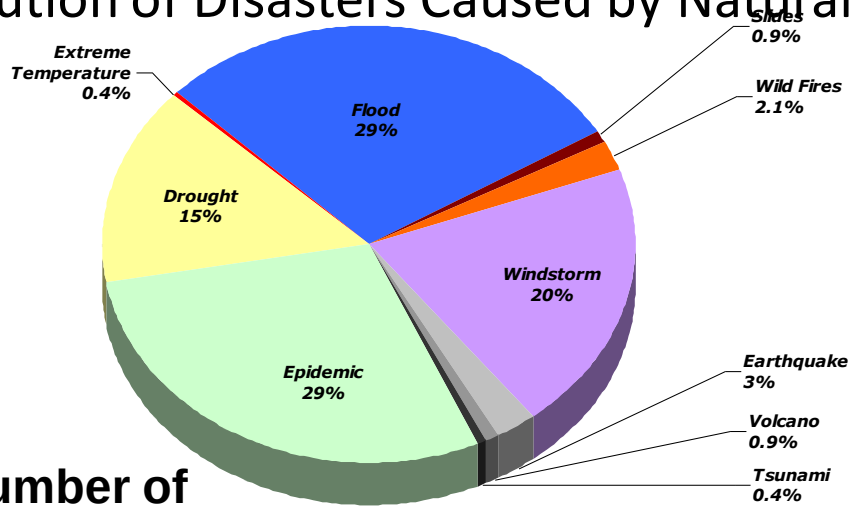


Drought of the Century

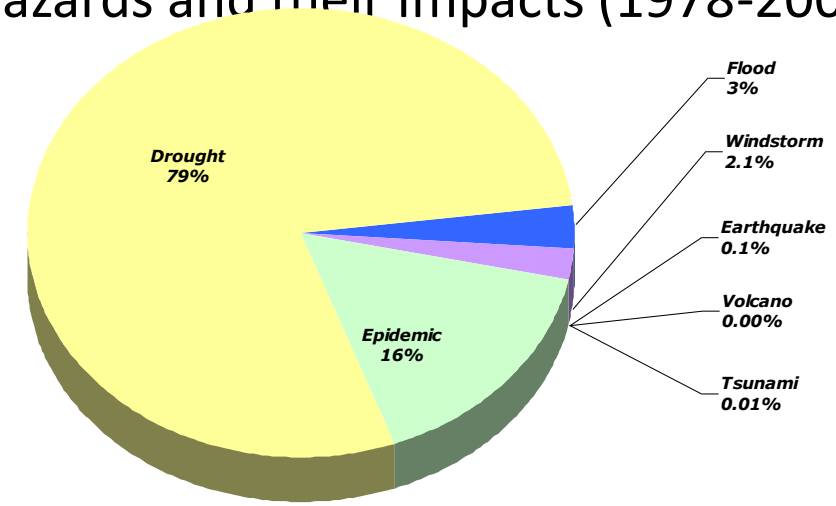
Drought Effect On Sugar Cane, Year 1998-99

Lightnings & Tornadoes

Distribution of Disasters Caused by Natural Hazards and their Impacts (1978-200

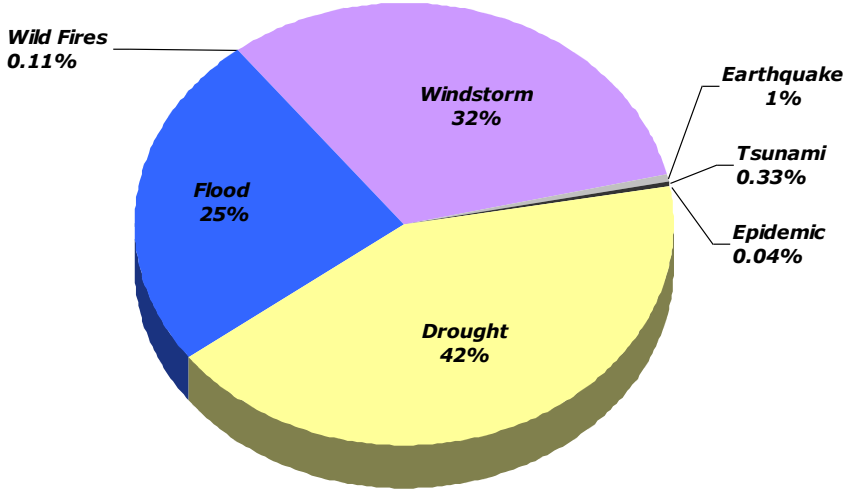


Number of events



Loss of life

Angola
Botswana
Comoros
Lesotho
Madagascar
Malawi
Mauritius
Mozambique
Namibia
Seychelles
South Africa
Swaziland
Tanzania
Zambia
Zimbabwe

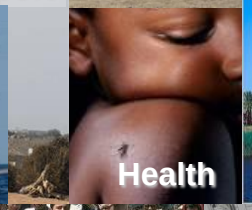


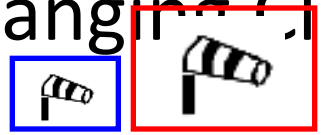
Economic losses

Source: EM-DAT: The OFDA/CRED International Disaster Database - www.em-dat.net - Université Catholique de Louvain -

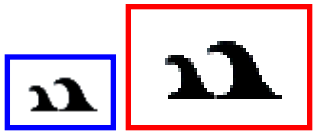
95% of events, **99%** of casualties and **99%** of economic losses are related to hydro-meteorological hazards.

Increasing Risks under a Changing Climate

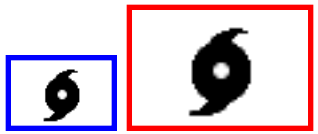




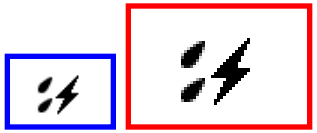
Strong Wind



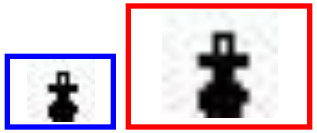
Coastal Marine Hazards



Tropical Cyclones



Heavy rainfall / Flood



Heatwaves

Hazards' intensity and frequency are increasing

Exposure is increas

Need for disaster risk management

Conclusions from 4th IPCC Assessment Report
WG II: Impacts, Adaptation and Vulnerability

Phenomenon	Likelihood	Major projected impacts
Increased frequency of **heat waves**	Very likely	Increased risk of heat-related mortality
Increased frequency of **heavy precipitation** events	Very likely	Increased loss of life and property due to flooding, and infectious, respiratory and skin diseases
Area affected by **drought increases**	Likely	Increased risk of food and water shortage
Intense **tropical cyclone activity** increases	Likely	Increased risk of deaths, injuries, water- and food-borne diseases; Disruption by flood and high winds; Potential for population migrations, loss of property
Increased incidence of **extreme high sea level**	Likely	Increased risk of deaths and injuries by drowning in floods; Potential for movement of populations and infrastructure

How do we define extremes?

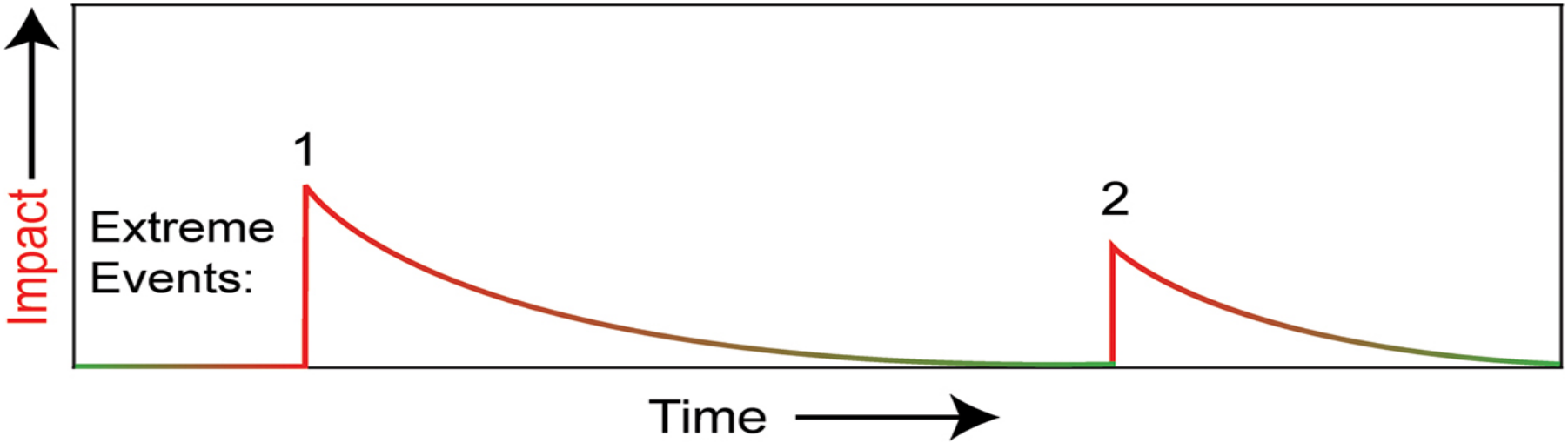
- IPCC AR4 Glossary: “an extreme weather event is an event that is ***rare*** at a particular place and time of year”

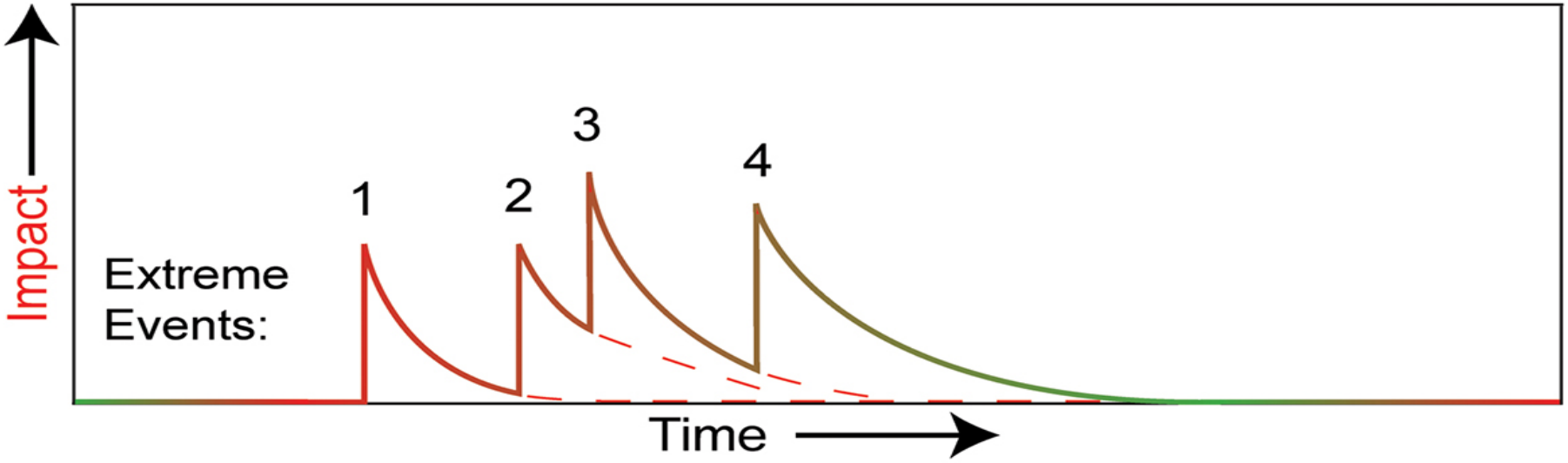
- “***rare***” is defined as the highest or lowest 10%.

Are We Seeing Changes in Extremes?

- Yes, there is evidence for observed changes in weather and climate extremes.
- Model projections suggest we will continue to see changes.
- Some changes have been attributed to human-induced climate change.

Extreme Events and Recovery of a System





Variability and changes in extremes

- Extreme weather events becomes more intense and more frequent→economic and social costs of those events are increasing,
- In drier areas→climate change is expected to lead to salinisation and desertification of agricultural lands
- South Indian Ocean may suffer a decrease of water resources due to climate change, with increasing precipitation variability with more dry spells and drought, and also a decrease in the groundwater recharge, and the rapid increase of population and water demand will exacerbate vulnerability.

Climate-related disasters

•There is evidence from various sources that suggests that climate-related disasters are increasing in frequency at the global scale

•By climate-related disaster, we mean a detrimental outcome of a climatic event due to a system on which humans directly depend.

•Such a disaster is precipitated by the climatic event in question (for example an extreme precipitation event, windstorm, or drought), but its nature and severity is mediated by a variety of non-climatic factors and processes that serve to dampen or amplify the primary impacts of the triggering event.

•Changes in the frequency of climate-related disasters are therefore not necessarily caused by meteorological changes, and are not necessarily attributable to global climate change.

Projected changes in extremes

Intensity of precipitation events is projected to increase.

Even in areas where mean precipitation decreases, precipitation intensity is projected to increase but there would be longer periods between rainfall events.

"It rains less frequently, but when it does rain, there is more precipitation for a given event." (Tebaldi et al. 2006)

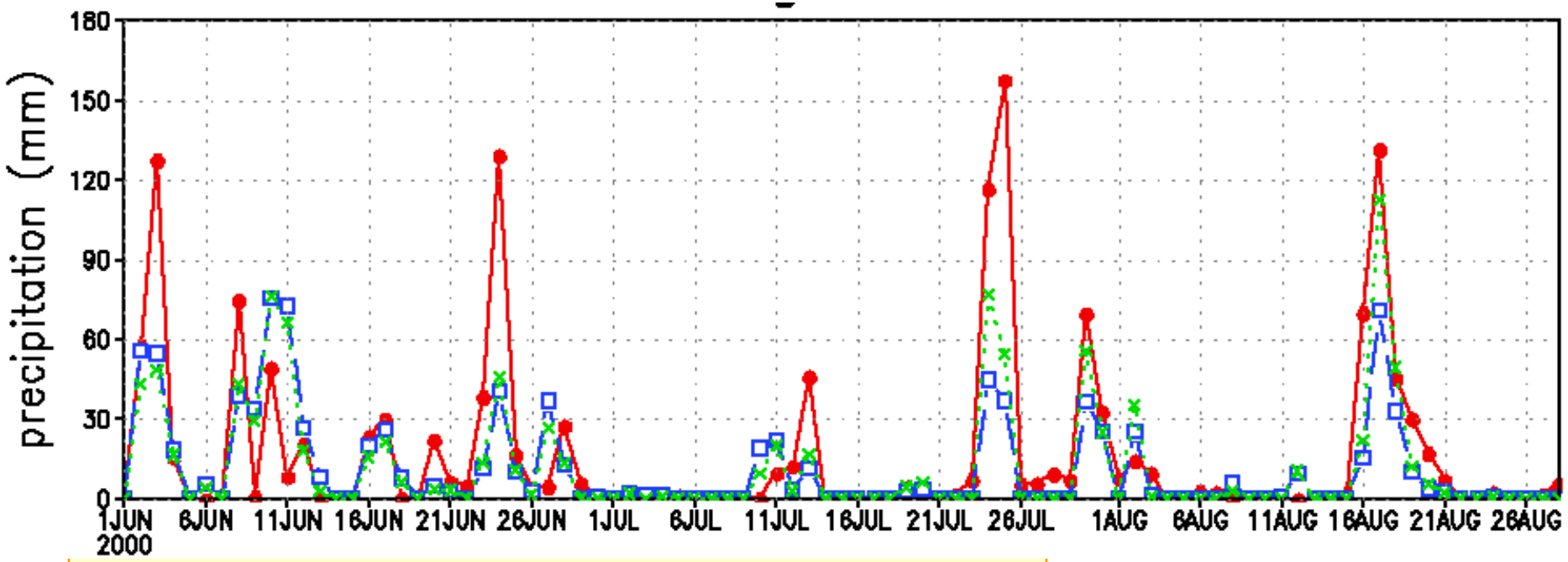
Extremes will have more impact than changes in mean climate

IPCC AR4

Observed data for extremes sufficient?

Can we use satellite-based daily precipitation data to study extreme events?

Daily Precipitation for June to August, 2000 at Kagoshima (mm/day)

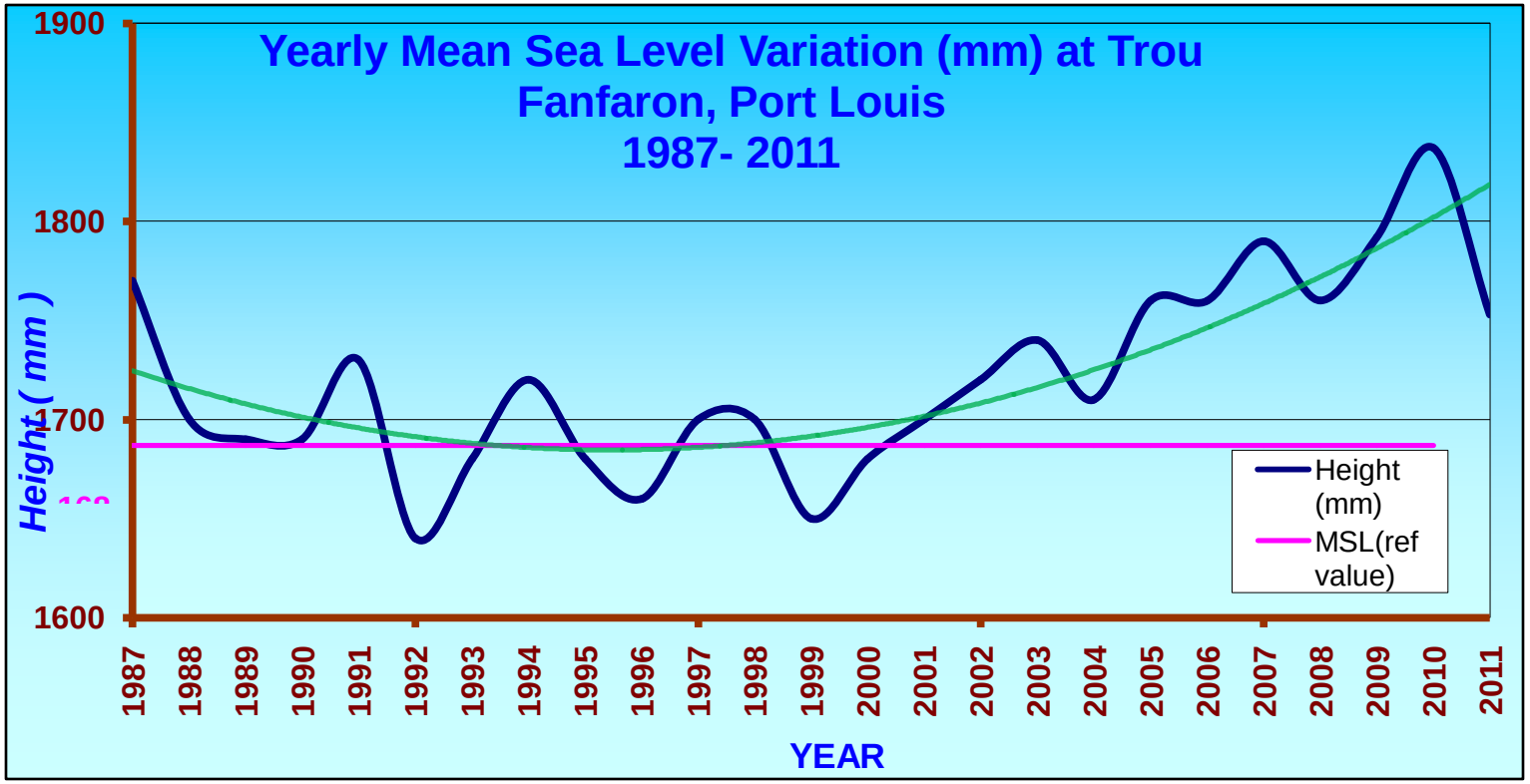


heavy precipitation compared to rain-gauge-based observation (Radar-AMeDAS)

● Radar-AMeDAS
□ GPCP-1DD
× TRMM3B42

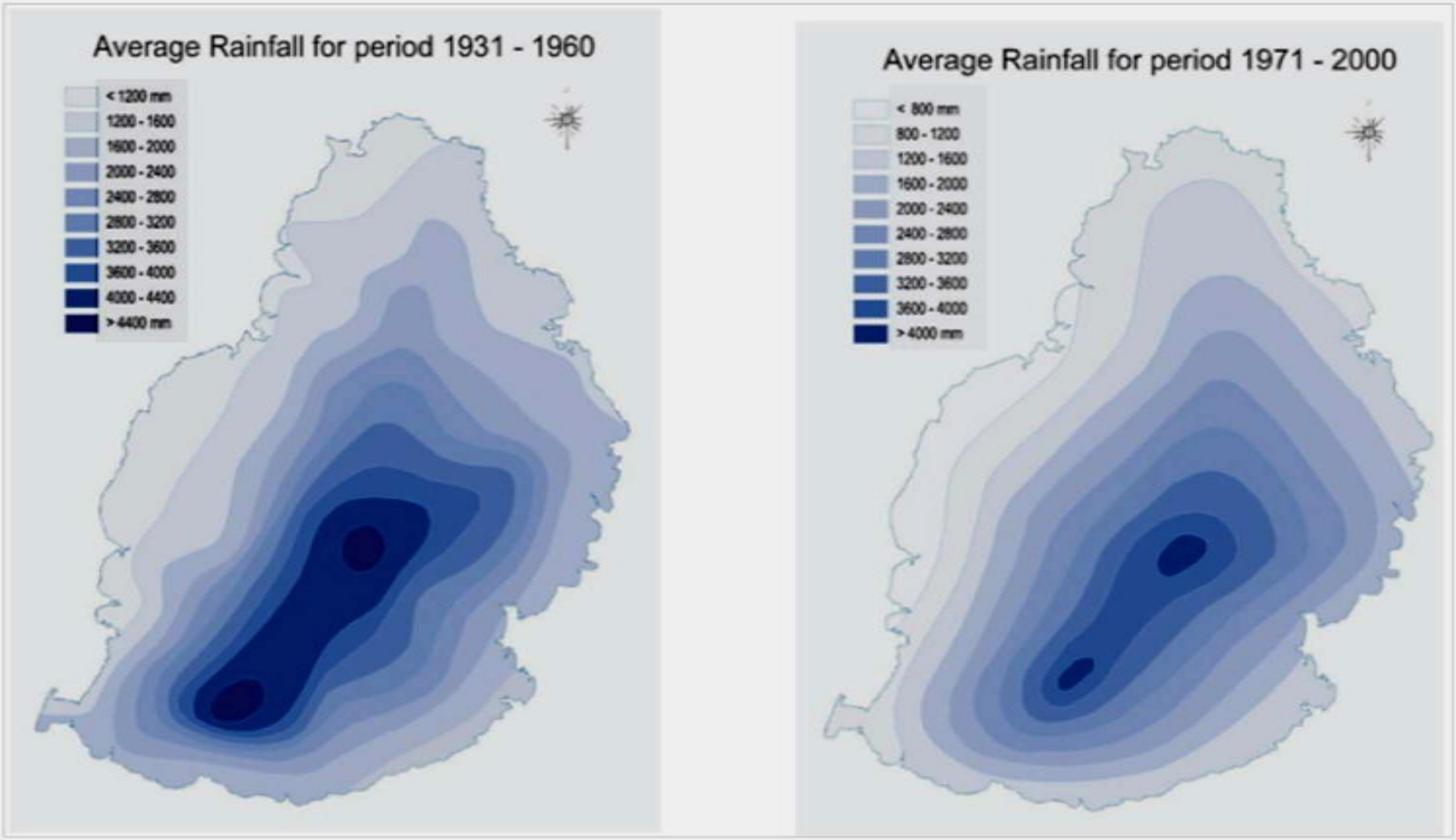
Satellite-based rainfall estimation is not sufficient to validate extreme precipitation events simulated by high-resolution models

Sea Level Rise

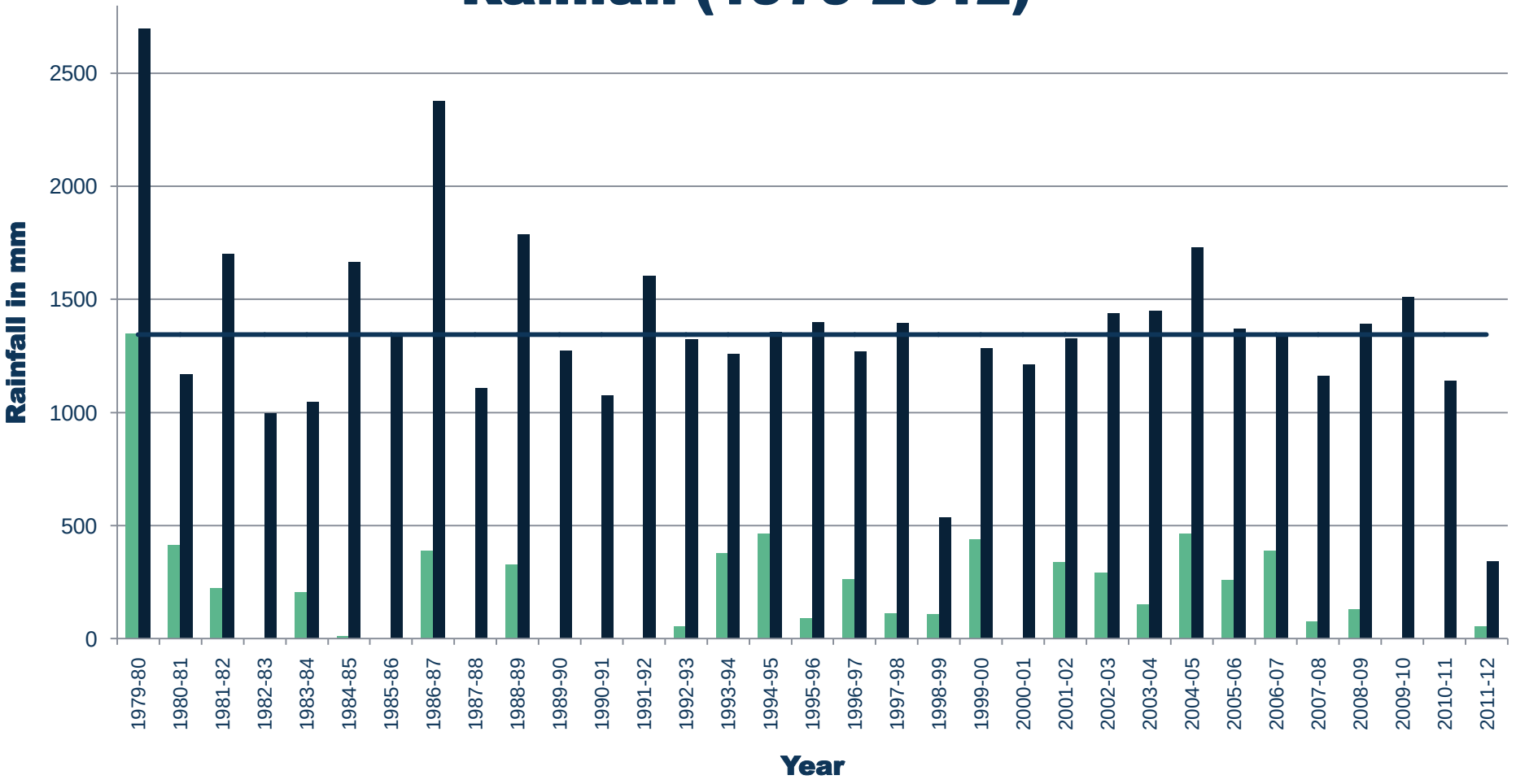


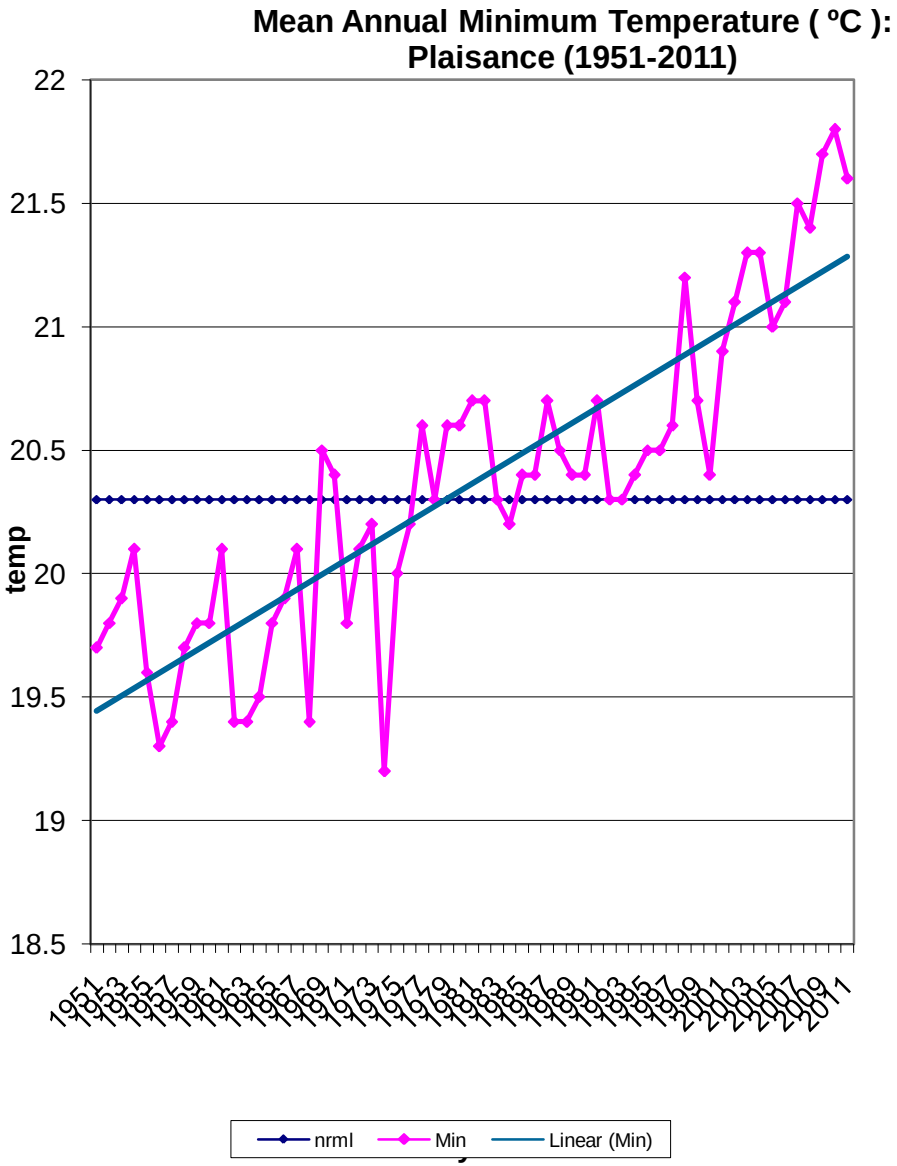
Sea level analysis shows a tendency towards an increase in sea level.

Rainfall has Decreased by about 400mm over the Central Plateau



Contribution from cyclones to Summer Rainfall (1979-2012)




Mean Annual Minimum Temperature (°C):
Plaisance (1951-2011)
temp
22
21.5
21
20.5
20
19.5
19
18.5
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
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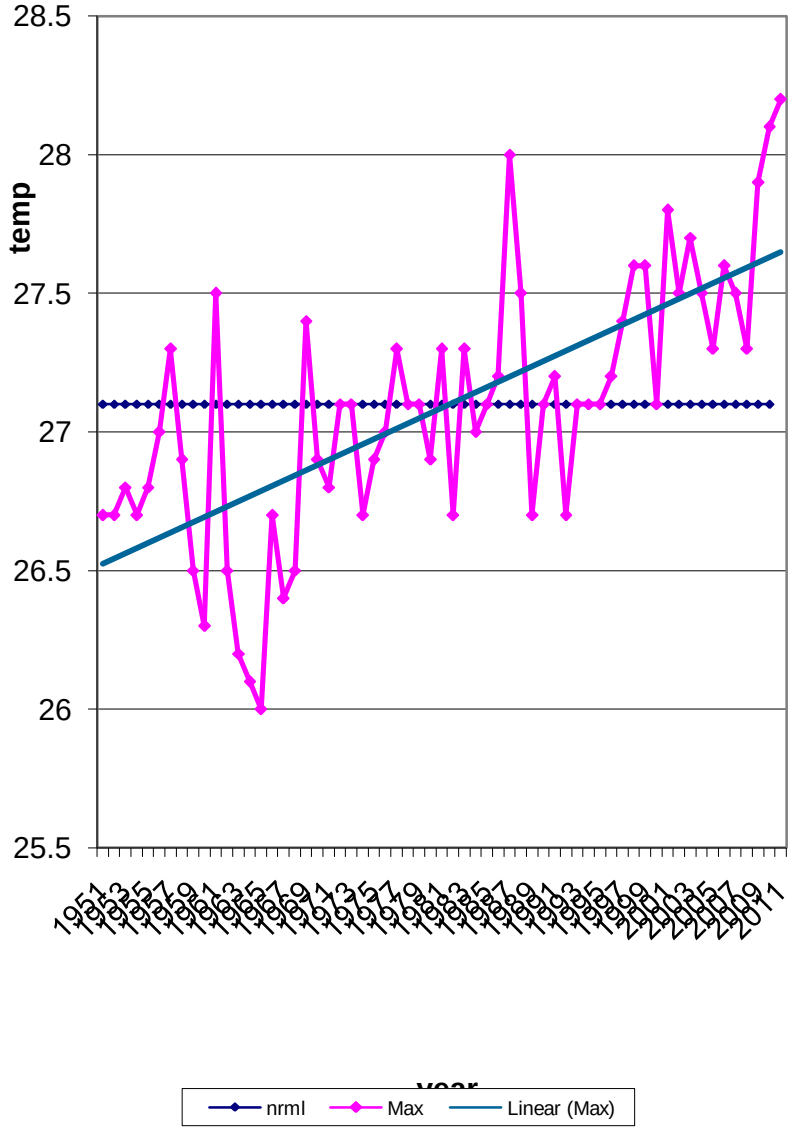
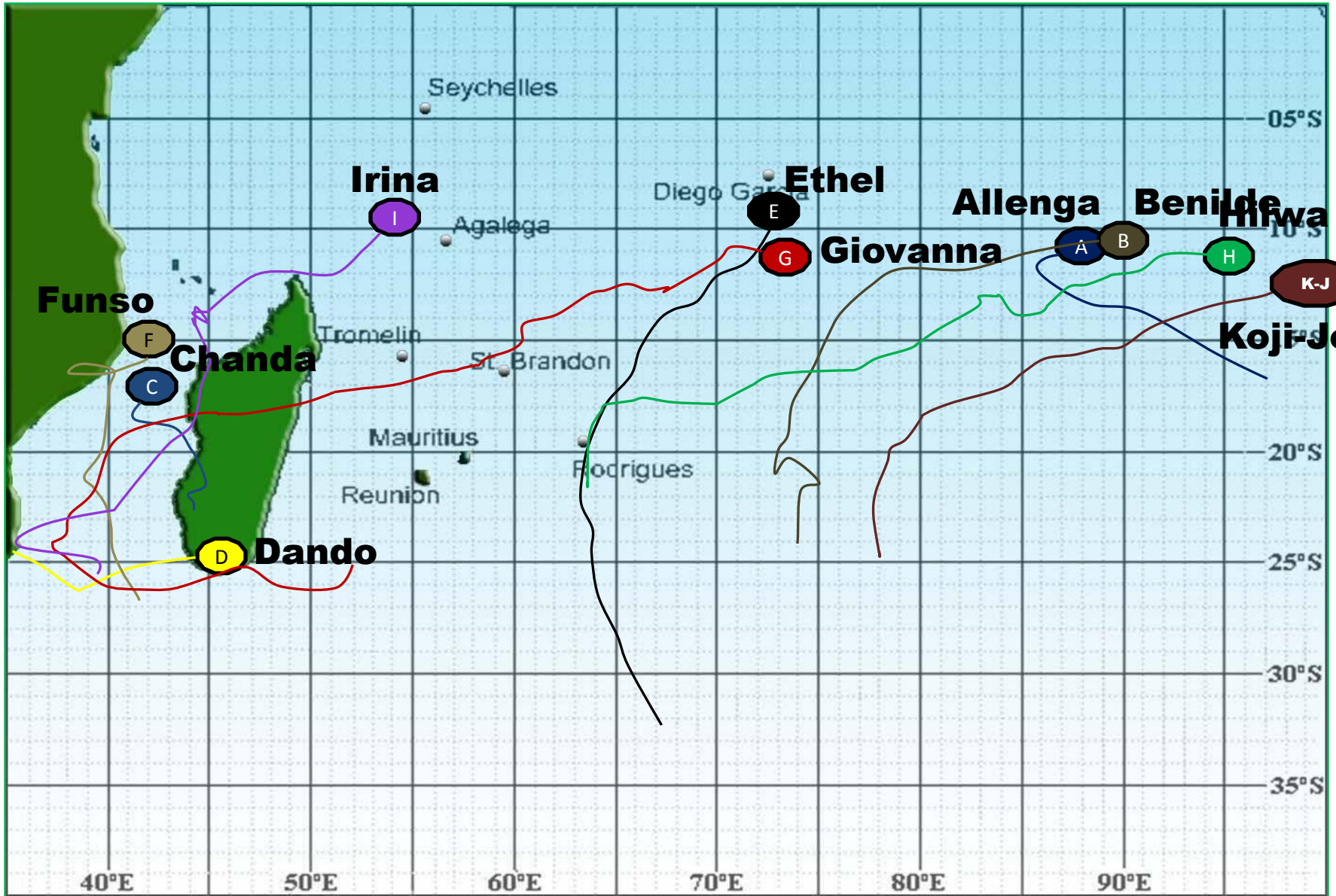
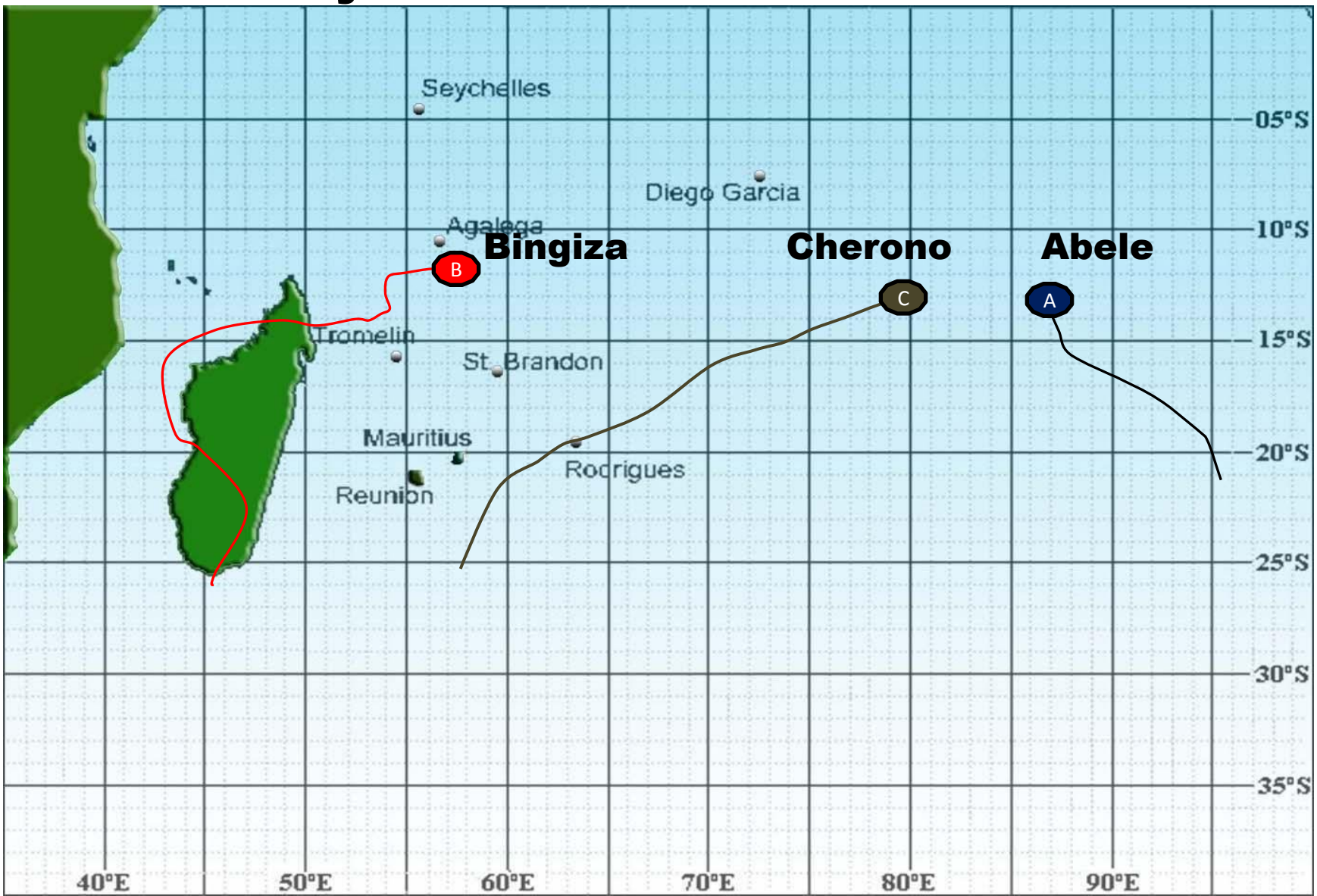
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
nrml
Min
Linear (Min)


temp
28.5
28
27.5
27
26.5
26
25.5
1951
1953
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
year
nrml
Max
Linear (Max)

Cyclone Season 2011/2012



Cyclone Season 2010/2011



possible impacts of climate change and extremes : How to face it?

- Improve regional and global climate models, including historical trend analyses
- Compile comprehensive integrated models of climate change impct
- Create vulnerability metrics to understand country's vulnerability to the impacts of climate change.
- Prepare and test adaptive responses to address and prepare for inevitable climate driven events such as massive migration and food and water supply shortages.
- Explore local implications of climate change and extremes in urban and rural areas, and develop estimates economical damages. Risk management can be applied in all of these contexts.
- Future sustainable development plans should include adaptation strategies to enhance the integration of climate change into development policies.

Temperature Variability

- **no warming trend since 1997**
- **choosing a starting or end point on short-term scales can be very misleading. Climate change can only be detected from multi-decadal timescales due to the inherent variability in the climate system**
- **If you use a longer period the trend looks very different. For example, 1979 to 2011 shows 0.16°C/decade**
- Each decade was warmer than the previous – so the 1990s were warmer than the 1980s, and the 2000s were warmer than both. Eight of the top ten warmest years have occurred in the last decade.
- Over the last 140 years global surface temperatures have risen by about 0.8ºC
- **The current period of reduced warming is not unprecedented and 15 year long periods are not unusual**
- **factors other than CO2 – such as multi-decadal oceanic cycles – may exert a greater influence on climate than previously realised?** limited observations on multi-decadal oceanic cycles but we have known for some time that they may act to slow down or accelerate the observed warming trend. changes in the surface temperature occur not just due to internal variability, but are also influenced by "external forcings", such as changes in solar activity, volcanic eruptions or aerosol emissions. Combined, several of these factors could account for some or all of the reduced warming trend seen over the last decade – but this is an area of ongoing research.

THE PERILS AFFECTING THE REGION / SOCIO-ECONOMIC DATA

2010	Madagascar	Mauritius	Comoros	Seychelles	Zanzibar	La Réunion
GDP million US $	9 947	11 310	610	1 007	590	17 500
Population ‘000s	21 320	1 290	754	86	1 000	830
GNI per capita US $	430	8 240	770	11 130	526	22 500
Surface Km2	592 000	2 040	1 862	453	2 328	2 512
Population living below 5m elevation above sea level	2%	6%	14%	42%		7%
Population living within less than 100km from the sea	50%	100%	100%	100%	100%	100%

THANK YOU